

# Why am I me? and why is my world so classical?

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19 November 2000

## Abstract

This is an attempt to apply Nagel's distinction between internal and external statements to the interpretation of quantum mechanics. I propose that this distinction resolves the contradiction between unitary evolution and the projection postulate. I also propose a more empirically realistic version of the projection postulate. The result is a version of Everett's relative-state interpretation, including a proposal for how probabilities are to be understood.

Based on a talk given at the 9th UK Foundations of Physics meeting in Birmingham on 12 September 2000.

In this talk I want to explore the possibility of a connection between the problem of understanding quantum mechanics and a number of classical philosophical problems. For this purpose, I will at first focus on the measurement problem, which can be given a conveniently concise formulation: the contradiction between the Schrödinger equation and the projection postulate. We appear (at least immediately after reading our first quantum mechanics textbook) to have good reason to believe both of these incompatible statements. The problems to which I want to compare the measurement problem can also be formulated as contradictions between pairs of statements or principles, both of which we seem to have good reason to believe:

1. The existence of space-time *vs* the passage of time;
2. Determinism *vs* free will;

3. The physical description of brain states *vs* conscious experience;
4. Duty *vs* “Why should I?”

One thing that all of these oppositions have in common with that between the Schrödinger equation and the projection postulate is that in every case one of the statements is a general universal statement — what Nagel [14] calls “a view from nowhere” — to which assent seems to be compelled by scientific investigation or moral reflection; the other is a matter of immediate experience (a view from “now here”). In other ways there may seem to be less similarity between the problem of quantum mechanics and the others. One difference for me personally is that although the contradiction between the Schrödinger equation and the projection postulate is sharp and uncomfortable, I do not see any contradiction in most of the other cases. This, of course, is favourable for my project: if I can succeed in establishing a relation between all these pairs, then I can hope that the solvent that removes the other contradictions will also work on the quantum-mechanical one. First, however, I have to recall the other contradictions to myself so that I can see how they go away.

For some of my audience, I think, all of the above contradictions have sharp teeth. In an attempt to bring us all together to share the experience of summoning up a vanished tension and watching it relax, I would like to start by considering the problem of my title. This is slightly different from the others, in that it is not a contradiction, but it brings us very directly to what I take to be the insight of Nagel [13, 14], which he applied to the other contradictions and which I will attempt to apply to the interpretation of quantum mechanics.

### WHY AM I ME?

At the age when philosophy is a natural and urgent activity, children often ask “Why am I me?”. What can they mean by this question? “I” and “me” are different grammatical forms of the same substantive; they have the same referent. How can it be problematical that they are identical? Yet what the question seems to be expressing is the sense that it is *contingent* that I am me. Can that make sense? Might I not have been Tony Sudbery — might I have been Mick Jagger? Clearly not; “I”, when spoken by me, denotes Tony Sudbery, and Mick Jagger is a different person. It is not logically possible that these distinct individuals could be equal. But the child in me would say “Yes, I might have been Mick Jagger” and I understand him; there seems to be a sense in which that is true. If so, the subject of the sentence cannot

after all be “Tony Sudbery”. Attempts to identify the true subject of the sentence might lead me astray, towards “I who am inside Tony Sudbery” or “I who experience the world as Tony Sudbery”, but Nagel has shown a better way. Let us just say that “I” is not always a simple synonym for the (objectively definable) speaker; it sometimes refers to the experiencing subject. In the world of each of us, there are many human beings, but there is only one experiencing subject. It would be a neat theory to declare that children ask “Why am I me?” at an age when they have only just realised that other people also experience the world as subjects, but I doubt if this is true. The human faculty of projection, of seeing other human bodies as persons, probably develops before the faculty of language. Nevertheless, the question expresses the tension between the knowledge that there are many persons, each of whom experiences the world in the same way that I do, and the more immediately known fact that there is only one such experience to which I can directly attest. It is contingent that that directly attested experience is what it happens to be in my life; that I (the experiencing subject) am me (Tony Sudbery).

## THE FLOW OF TIME

Many physicists find a contradiction between their experience of time and the description of time that they give as physicists. For example:

1. For us convinced physicists the distinction between past, present and future is an illusion, although a persistent one. (Einstein [10])
2. Things don’t *happen* in spacetime, they simply *are*. (Paul Davies [7])
3. Relativity ... seems incapable of describing the flow of time at all: past, present and future co-exist in a four-dimensional “block”, dubbed space-time. (Bernard Carr [5])
4. There seems to be no strong reason for supposing that the flow of time is any more than an illusion produced by brain processes similar to the perception of rotation during dizziness. (Paul Davies [7])

I don’t myself share this sense of contradiction. If the flow of time is an illusion, what is it that we mistakenly believe when we are under this illusion?<sup>1</sup> Not that time flows, because that doesn’t make sense: only substances flow, and time is not a substance. Paul Davies’s illusion, in fact, is itself illusory.

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<sup>1</sup>A similar question can be asked about the supposed illusion of free will.

Einstein's assertion that there is no distinction between past, present and future, on the other hand, seems to be simply mistaken. The past, the present and the future are the sets of events with time coordinates  $t$  satisfying  $t < t_0$ ,  $t = t_0$  and  $t > t_0$  respectively, where  $t_0$  is a certain time which I can specify — 11.20 on 8 September, 2000, actually. It is no illusion that there is a distinction between these sets; they are distinct sets. What lies behind this idea of an illusion, of course, is Einstein's discovery that the distinction differs from observer to observer. This does not alter the fact that in every frame of reference (and for every choice of  $t_0$ ) there is such a distinction, and it does not make the distinction any less real and objective.

However, arguments about the relativistic meaning of past, present and future seem to miss the essential point. The immediate application of these terms is to events in one individual's experience, that is to events on a particular worldline. The division of these events into past, present and future is relativistically invariant — though it does, of course, depend on the specification of a particular event on the worldline as “now”.

The other quotations above are even easier to demolish. It is true that things (Davies means “events”) *are* in space-time, but why does that mean that they don't *happen*? Happening, as a matter of linguistic fact, is just what events do. Finally, if Davies's statement (4) is a meaningless expression of subjective experience, Carr's description (3) of objective space-time is clearly self-contradictory, or becomes so if we replace “co-exist” by “exist at the same time”, which is what Carr seems to mean. It is obviously not true that all the events in space-time exist at the same time, for events are defined by coordinates  $(t, x, y, z)$ , and they do not all have the same time  $t$ .

But having fun with the daft things that physicists say about time doesn't shed much light on the question of why there is such a widespread feeling that physicists' notion of space-time contradicts what we know from experience about time. My comment on Carr's statement (3) reduces this contradiction to a confusion between the time at which an event happens and the time at which it is discussed; but recognising this distinction doesn't seem to remove the puzzlement which we often feel when thinking about time in our own lives. It was this which was expressed by St. Augustine:

How can the past and future be when the past no longer is and the future is not yet? As for the present, if it were always present and never moved on to become the past, it would not be time but eternity.

I want to analyse this puzzlement in two different but related ways. First, there is a sense that statements referring to the present and the future cannot

both be true, because they contradict each other. Consider a prisoner who is due to be released this weekend. His being in prison and his being free cannot both be true; hence if it is true that he is in prison, the future (in which he is free) cannot exist. Logically, the resolution is easy: the two states have been incompletely described, and if we complete them by specifying their time they are not contradictory: being in prison on 8 September is certainly compatible with being free on 15 September. But in terms of actual experience a sense of contradiction remains. Our experience is completely specified without a time label — we only experience *one thing at a time* — and adding time labels does not make imprisonment and freedom compatible states in our experience. The prisoner, desperately longing for next week, finds it hard to really believe that he *will be* free because he all too clearly *is* in prison. The purely intellectual acknowledgement of the truth of a statement referring to a remote time is shadowy and pale in comparison to the vivid knowledge of what we are experiencing *now*. The first is an external statement; the second is internal.

The second point to note starts as a linguistic one. Augustine points out that it cannot be true to say that the future exists because it *is not yet*. This contradicts the physicist’s assertion that all the events of space-time simply *are*. Augustine would say that this is wrong; it is not true that future events *are*, only that they *will be*. We cannot make a statement in ordinary language without giving it a tense. In the mathematical language in which, fortunately, statements of physics can be expressed, this restriction does not operate. In this language we can express the prisoner’s present confinement and his future freedom by considering his time-dependent state  $|\psi(t)\rangle$  and using the tenseless = sign to write

$$\begin{aligned} |\psi(8 \text{ September})\rangle &= |\text{in prison}\rangle, \\ |\psi(15 \text{ September})\rangle &= |\text{free}\rangle. \end{aligned}$$

Philosophers sometimes enviously adopt this feature of mathematical expression by inventing a “tenseless” form of verbs in ordinary language. This distinction between tensed and tenseless statements can help to explain the perceived tension between the existence of space-time and our experience of time: physical statements about events in space-time (external statements) are tenseless, whereas statements that we make in space-time are always tensed, with an implied “now”. The reason why space-time is taken to be an odd idea, contradicting our intuition, is that statements about it (like Davies’s (2)) are tenseless statements expressed in a language that has no tenseless forms. They are therefore falsely understood as tensed statements, as which they appear commensurate with the tensed statements of our experience, and may indeed contradict them. My argument that this contradiction

can be resolved depends on the existence of a translation from a tensed statement, together with its context, to a tenseless one, in which one moves the context (the identification of “now”) into the statement; thus

“I will be free in one week’s time” uttered on 8 September

translates to

$$|\psi(15 \text{ September})\rangle = |\text{free}\rangle.$$

## EXTERNAL SMOOTHNESS, INTERNAL COLLAPSE

I now want to propose that a distinction between internal and external statements like that between tensed and tenseless ones, or between an experiencing subject (I) and a physically identified body (me), can be used to resolve the contradiction between the two conflicting laws of evolution in quantum mechanics: the discontinuous, probabilistic change in the state vector following a measurement, given by the projection postulate, and the continuous, deterministic evolution given by the Schrödinger equation. The idea, roughly speaking, is that the Schrödinger equation is an external statement, while the projection postulate is an internal one. More precisely, let  $|\Psi(t)\rangle$  be a time-labelled sequence of states satisfying the Schrödinger equation. Then it is an external (and tenseless) statement that the world passes through the sequence of states  $|\Psi(t)\rangle$ . Suppose that at early times the state is a product  $|\phi\rangle|\psi\rangle$  where  $|\phi\rangle$  is a state of a measuring apparatus and a conscious observer, while  $|\psi\rangle$  is the state of the rest of the world (or simply the system being measured by the apparatus), and suppose the Hamiltonian includes an instantaneous measurement made at time  $t_0$ . Then the solution of the Schrödinger equation with this Hamiltonian and these initial conditions will be of the form

$$|\Psi(t_0 + \varepsilon)\rangle = \sum_n c_n |\phi_n\rangle |\psi_n\rangle$$

where the  $|\psi_n\rangle$  are eigenstates of the measured observable,  $c_n$  are the coefficients in the expansion of  $|\psi\rangle$  in terms of these eigenstates, and  $|\phi_n\rangle$  is the state of the apparatus and observer in which the apparatus registers the result  $n$  and the observer is aware of that result. This is an external statement (about the whole universe), but it is compatible with the internal statement (a tensed one, with a “now” of  $t_0 + \varepsilon$ ) that after the measurement the state  $|\psi\rangle$  has jumped to one of the eigenstates  $|\psi_n\rangle$ , the warrant for which is the

experienced fact that the observer's state has jumped to the corresponding  $|\phi_n\rangle$ .

The apparatus-observer state  $|\phi_n\rangle$  can be analysed as

$$|\phi_n\rangle = |\text{"The result is } n\text{"}\rangle|\alpha_n\rangle$$

in which  $|\alpha_n\rangle$  is an apparatus state and a ket symbol containing a quoted statement represents a state of the observer in which they believe that statement. Thus the external description of the universe is the superposition

$$|\Psi(t_0 + \varepsilon)\rangle = \sum_n c_n |\text{"The result is } n\text{"}\rangle|\alpha_n\rangle|\psi_n\rangle.$$

We see very clearly here that it is correct to call the statements of the result of the measurement “internal statements”: they occur *inside* the external statement, as part of the physical world. They are configurations of a physical system, namely the brain of the observer. But they are also propositions. What is their status as propositions: are they true or false? Each is believed by a brain which has observed the fact it describes, and that fact belongs to reality. As a human belief, each statement could not be more true. Yet they cannot all be true, for they contradict each other. I take this to be characteristic of internal statements in a physical system; the belief of such a statement is a physical occurrence, and its truth can only be assessed in the physical context in which it occurs. In the present situation, such a context consists of a particular component of the universal state  $|\Psi(t)\rangle$ .

## PROBABILITIES

Clearly what I am proposing here is an understanding of Everett's relative-state interpretation. Notoriously, this interpretation has a problem with the probability statements of quantum mechanics. The distinction between internal and external statements opens a new approach to this problem. There are two aspects to this. First, probabilities are attached to the results of measurements. But statements about the results of measurements must be internal — it is only from a particular perspective that a measurement *has* a result — so we must be prepared to accept that probabilities are only relevant to internal statements. A statement of probabilities will not be itself an internal statement, but it will be *about* internal statements.

Secondly, I find that I cannot understand probabilities in quantum mechanics unless I move to a formulation of the probabilistic law about the results of experiments which is slightly different from the usual one: not equivalent to it, but somewhat stronger — though no stronger, I believe, than

the (unformulated) law which is actually used by the practitioners of quantum mechanics. I have argued elsewhere [19] that the conventional postulate, referring to the results of measurements, is not an adequate description of empirical reality. Not only is it incompletely specified, relying as it does on an undefined notion of “measurement”, but it also fails to give any answer to many experimental questions to which physicists need answers. It assumes that all experiments can be described as instantaneous measurements in which the experimenter actively provokes the system under investigation into providing a result, and consequently changing its state, by means of an instantaneous (or at least sharply time-dependent) intervention. This does not cover, and cannot be adapted to cover [19], the common situation in which the experiment consists of passively observing the system as it spontaneously changes, and the experimental setup is constant over an extended period of time.

In order to cover this situation of continuous observation, the probabilistic statements need to be in the form of transition probabilities. A convincing postulate was proposed by Bell [3]. In a generalised form ([18], p. 216), it consists of the assumption that the state of the system is always in one of a certain set of subspaces  $\mathcal{S}_m$ , and that it moves stochastically from one subspace to another with transition probabilities which are determined by the solution  $|\Psi(t)\rangle$  of the Schrödinger equation as follows. Let  $\Pi_m$  be the projection onto the subspace  $\mathcal{S}_m(t)$ , and let  $|\psi_m(t)\rangle = \Pi_m|\Psi(t)\rangle$ . Then at time  $t$  the system is in one of the states  $|\psi_m(t)\rangle$ , and if it is in  $|\psi_m(t)\rangle$  at time  $t$  then the probability that it will be in  $|\psi_n(t + \delta t)\rangle$  (where  $n \neq m$ ) at time  $t + \delta t$  is  $T_{nm}\delta t$  where

$$T_{mn} = \frac{\max(J_{mn}, 0)}{\langle \psi_n(t) | \psi_n(t) \rangle}, \quad (1)$$

$$J_{mn} = \frac{2}{\hbar} \text{Im} \langle \psi_m(t) | H | \psi_n(t) \rangle. \quad (2)$$

(This has been generalised to the case of time-dependent  $\Pi_m$  by Baccigaluppi and Dickson [2].) It follows from these transition probabilities that the usual probabilities for the results of measurements of  $\Pi_m(t)$  hold at all times if they hold at any one time.

At first sight there is a deeply unattractive and implausible feature of this proposal: it depends on the choice of the subspaces  $\mathcal{S}_m(t)$ , i.e. on a choice of preferred observable. Thus it appears to break the general unitary symmetry of quantum mechanics. But in the framework I am proposing here this is no vice. A report of an experimental result is an internal statement, made by a physical system which is capable of formulating propositions about its environment and having attitudes of belief towards those propositions — in



short, a conscious system. (I use the word “conscious” reluctantly, because I do not want to be understood as restricting the discussion to human beings, but it seems to be what I mean). A general statement about experimental results must therefore be made relative to the conscious system which reports the results. A conscious system, regarded *as* a conscious system, automatically defines a preferred set of subspaces, namely those consisting of states in which the conscious system has definite experiences — what Lockwood [12] calls the *consciousness basis*, though I will use the term *experience basis*.<sup>2</sup> If we are making general statements about the experiences of conscious systems, there is no loss of unitary symmetry in making each statement depend on the experience basis of the system to which it refers. This is the same as the way that statements about energy in special relativity are necessarily relative to a particular frame of reference; nevertheless, general statements about energy (for example, the conservation of energy) are possible and do not break relativistic invariance.

We thus arrive at the following general formulation of the laws of motion in quantum mechanics:

1. The universe is described by a time-dependent state vector  $|\Psi(t)\rangle$  in the universal state space  $\mathcal{S}$ , which evolves according to the Schrödinger equation.
2. The experience of any conscious subsystem  $C$  of the universe is described at any time  $t$  by a state vector  $|\phi_n\rangle$  in the experience basis of that subsystem’s state space  $\mathcal{S}_C$ . If this experience is described by  $|\phi_n\rangle$  at time  $t$ , then the probability that it is described by  $|\phi_m\rangle$  at time  $t + \delta t$  is  $T_{mn}\delta t$  where

$$T_{mn} = \frac{\max(J_{mn}, 0)}{\langle \psi_n(t) | \psi_n(t) \rangle}, \quad (3)$$

$$J_{mn} = 2 \operatorname{Im} [\hbar^{-1} (\langle \phi_m | \langle \psi_m(t) |) H (|\phi_n\rangle |\psi_n(t)\rangle)] \quad (4)$$

and the states  $|\psi_n(t)\rangle$  are the states of the rest of the world, (elements of  $\mathcal{S}_R$  where  $\mathcal{S} = \mathcal{S}_C \otimes \mathcal{S}_R$ ), which are the coefficients of the experience basis states in the expansion of the universal state vector with respect to this basis:

$$|\Psi(t)\rangle = \sum_n |\phi_m\rangle |\psi_n(t)\rangle.$$

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<sup>2</sup>In passing, let us note that an answer to the question “Why don’t we see superpositions of macroscopic states?” is that there is no experience state describing such seeing. A superposition of two experience states is not, in general, an experience state.

How does this solve the problem of probabilities in the relative-state interpretation? I haven't yet defined what I mean by the probabilities that occur in (2) above. But I don't know how to define probabilities in *any* physical theory. Popular definitions of probabilities are couched in terms of frequencies — but then they seem to me to be wrong, or at best circular; or in terms of degree of belief — but then they are not appropriate to physics. If it is to have the kind of objective meaning that is needed in physics, “probability” has to be taken as a primitive, undefined, term. Moreover, for its use in physics maybe one has to restrict the sorts of thing to which the word can be applied. I'm not sure that I know what would be meant by the objective probability of a proposition being true. I have the firmest sense that I understand objective probabilities when they refer to events happening. Then one could possibly essay a definition of the objective probability of a (future) event as “the degree of expectation of the event which is rational for a fully informed observer”, though this is more an elucidation than a definition. According to the version of quantum mechanics being proposed here, events happen in the experience of a conscious system (and only there, in the case of events like quantum jumps). It is therefore appropriate, and I claim comprehensible, for probabilities to occur in this part of the theory; and they do so as primitive terms, but with the meaning that I have indicated above.

## SUBJECTIVE AND OBJECTIVE

Except in the preceding paragraph (where my use of them will probably strike some of my audience as odd; I will explain), I have tried to avoid the words “subjective” and “objective”, though it might seem natural to use them for the distinction between what I have called “internal” and “external” statements (indeed Nagel uses them in the title of one of his early papers on the topic [13]). I think this would be a mistake. When this distinction is applied to quantum mechanics as I have been trying to do, the class of internal statements includes all the statements that we are used to making in classical physics (more precisely: it includes translations of all the external statements of classical physics, using the type of translation between internal and external that I discussed in connection with tensed and tenseless statements). Among such statements there is already a distinction between subjective and objective, so there are both subjective internal statements and objective internal statements. For example, I would make the subjective statement that the hair of most people in this room is a kind of green, though the objective fact, I understand, is that the colours in question are various shades of brown. Both statements are internal statements, made from inside one particular component of the state vector of the universe.

This is why I used the term “objective probability”, even though probabilities only refer to internal statements. I want to make the same distinction between objective probabilities as physical facts and subjective probabilities as degrees of belief that we would make in a classical stochastic theory. In ignorance of the way that Schrödinger’s diabolical experimenter prepared his device with the cat — not knowing which radioactive material he used, or how much of it, or how lethal was the poison — I might be prepared to state how probable I think it is that the cat will survive after an hour in the box, and to bet in accordance with that subjective probability; but there is a fact of the matter about how many radioactive nuclei there are in the box, and what their half-life is, and this determines the actual objective probability that the cat will survive for an hour. To spell this out in recognition of the internal nature of my statements, I should call this the probability that my experience in the next hour will not include a transition to seeing the cat dead. But since *all* my statements about the world are internal — they cannot be anything else — I am entitled to say (or at least to assume, and I will usually be right) that if I see the cat dead, then it *is* dead. My failure to spell out pedantically the internal status of my utterances is not just a shorthand but a justified assessment of what constitutes reality.

## REALITY

Which describes reality — the internal view or the external view? Both seem to have a good claim. As objective scientists, we might want to say that the external perspective is one which describes the whole of reality, whereas the internal perspective gives a partial or misleading view. This, we might consider, is the deep and true reality which quantum mechanics has revealed to us: all the components of the universal state vector (the “many worlds”, to use a familiar but unhelpful phrase) really exist, and it is only because of the limitations of our perceptual apparatus that we are not directly aware of them. On the other hand, one could take the view that the first allegiance of a scientist is to the results of experiments; if anything is real, they are. Thus *one* of the many worlds is real; the others form a shadowy sort of potential<sup>3</sup> which governs the evolution of the real world.

If there is a dispute here, it is surely a barren one. It doesn’t *matter* which of  $|\Psi(t)\rangle$  or  $|\phi_n(t)\rangle$  on page 9 we call “real”. This must mean that the two assertions “ $|\Psi\rangle$  describes reality” and “ $|\psi_n(t)\rangle$  describes reality” are

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<sup>3</sup>“Potential” here is a doubly appropriate word. The other components of the state vector represent outcomes which were potential but are not (from the internal perspective) actual; and they contribute to the evolution of the actual state in a way which is similar to the contribution of a potential function to the motion of a particle.

compatible, which is to say that “reality” has different senses in the two statements; and this is understandable if one of the statements is an internal one and the other is external.

It may be necessary to insist that abandoning the projection postulate in the external view of the universe is not to deny the reality of the projected component in which we find ourselves. Nagel also [14] has emphasised that internal statements should not be regarded as less true or complete than external ones. Indeed, there are some truths to which there can be no access from an external perspective, and no expression as external statements; they are none the less truths. Among these, for example, are facts about the quality of experience; I suggest that facts about the outcome of experiments have a similar status. We have already noted that the various statements of the outcomes of an experiment, although they contradict each other when viewed externally, are all as true as an empirical statement can be when viewed in their own context. It is no denial or denigration of the reality of an experimental result to say that there is a description of the world — not just a different description, but a different *kind* of description — in which the result features as just one component of a superposition of state vectors.

A similar contextualisation of truth and reality has been advocated by Simon Saunders, whose understanding of quantum mechanics in terms of decoherent histories [15, 16, 17] is close to the interpretation proposed here.

## HOW MANY WORLDS? HOW MANY MINDS?

Describing the Everett interpretation in terms of many worlds or many minds only exposes one unnecessarily to charges of metaphysical profligacy. Orthogonal components of a state vector are not separate worlds. There is only one world, and it has one state vector. That state vector contains a number of possible experiences, but no more minds than one would expect from a classical description of the world (one, if one is a solipsist; the number of fertilised human ova, if one is a Catholic; the number of human beings beyond one’s favourite stage of development, if one is a speciesist; ...). From an external point of view, there are a number of possible experiences; many of those experiences belong to the same mind. It seems to me to be a mistake to describe this multiplicity of experiences as a multiplicity of minds [12, 1, 9], since it makes the correspondence between minds and brains many-to-one. The mistake is to confuse brain *states* with brains.

This mistake is similar to one made by Deutsch [8], in which form it can perhaps most clearly be seen to be a mistake. Deutsch takes the two-slit experiment with electrons to demonstrate that each electron going through one of the slits must be knocked off course by *another* electron which went

through the other slit. This electron lives in “another world”, and is analogous to the other minds postulated by many-minds theorist. But the state of the universe in the two-slit experiment, with one electron, is in an eigenstate of electron number, and the eigenvalue is 1. There is only one electron. Equally, there is only one brain for each human observer, and therefore only one mind.

## SUMMARY

1. One must distinguish between an external statement about a physical system and internal statements made within the system. An internal statement is necessarily relative to a particular perspective.
2. A perspective in a quantum system consists of:
  - (a) a conscious system;
  - (b) an instant of time;
  - (c) an eigenstate of experience.
3. An external statement about a quantum system (in particular, the universe) consists of a description of its state vector as a function of time. The physical law to which this statement is subject is that the state vector obeys the Schrödinger equation.
4. An internal statement in a quantum system is a description of an experience of a particular conscious system at a particular time. The physical law to which this statement is subject is that the experience state changes stochastically according to the transition probabilities (2).

It is often said that among the problems concerning the relation between classical and quantum mechanics is the question “What determines which one of the classically allowed states is in fact actualised?” [6]. If we accept that physics has been forced to abandon determinism, we should not be surprised that there is no answer to this question; but there is still a puzzle about the way in which indeterminism is incorporated by quantum mechanics, with its apparently deterministic equation of motion. The argument of this paper has been that the relation between different classical outcomes to a quantum experiment is analogous to the relation between different instants of time (an analogy which has also been made by Lockwood [12]) and also to the relation between different centres of consciousness. We should no more expect to be able to answer “Why did the experiment have that outcome?” than “Why is it now *now*?” [11] or “Why am I me?”

## Acknowledgement

I would like to acknowledge the inspiration I drew from Tom Baldwin's inaugural lecture, *Inside Out or Outside In?* Professor Baldwin should not, of course, be held responsible for the amateurishness of the philosophising that his lecture inspired in an amateur. I am also grateful to James Ladyman, Harvey Brown and Charles Francis for helpful comments and for directing me to some relevant literature.

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